Pt-Ir ALLOYS AS THE ELECTROCATALYST FOR AMMONIA FUEL CELLS

Kazuki Endo, Yasushi Katayama and Takashi Miura

Department of Applied Chemistry,

Faculty of Science and Technology, Keio University

Hiyoshi 3-14-1, Kohoku-ku, Yokohama 223-8522, Japan

INTRODUCTION

Ammonia is attractive as a liquid fuel for mobile use, since it is easy to handle under low pressure, costs only slightly higher than methanol and can be cracked into hydrogen and nitrogen by elevating temperature. Anodic oxidation of ammonia as well as methanol enables the compact direct fuel cell system. Theoretical cell voltage and energy density per unit fuel weight of direct ammonia fuel cell are compatible to those of methanol one. In addition, direct ammonia fuel cell produces only water and nitrogen [1]. In order to realize ammonia fuel cells, however, the development of active electrocatalyst is required to oxidize inactive ammonia. In this work, Pt-Ir binary alloys were evaluated as the ammonia oxidation electrode.

EXPERIMENTAL

A series of Pt_xIr_{1-x} electrodes were prepared by thermal decomposition at 450 °C for 2 h under H_2 (10%)-N_2 (90%) flow after loading $H_2PtCl_6 \cdot 6H_2O$ and $IrCl_3 \cdot nH_2O$ ethanolic solutions on a glassy carbon (GC, 1 cm^2) substrate. Nominal metal loading was 0.6 mg in total. These electrodes were analyzed by X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectrometry (EDX), and X-ray photoelectron spectroscopy (XPS). Electrochemical measurements were performed in 0.1~1 M NH_3 + 1 M KOH using the Pt counter and Ag/AgCl reference electrodes. The real surface area of electrode was determined from the amount of oxidation charge of preadsorbed carbon monoxide in 0.5 M H_2SO_4 [2].

RESULTS AND DISCUSSION

Prepared Pt_xIr_{1-x} alloys were single-phase on an XRD basis, and their lattice constants increased linearly with x. Although there were some cracks were on the electrode surfaces, the segregation of neither Pt nor Ir was observed.

Typical current-potential curves of these Pt_xIr_{1-x} electrodes in 0.1 M NH_3 + 1 M KOH are compared in Fig. 1, where current densities were calculated from the real surface area and the potentiostatic polarization current after 60 s. The ammonia oxidation seems to begin at –0.65 V on Ir (x=0), lower than on Pt (x=1) by about 0.1 V. The ammonia oxidation current tends to saturate at >–0.50 V and the oxidation rate in this potential region is lowest on Ir.

As seen in Fig. 2, the oxidation rate in this potential region is higher on binary alloys of 0<x<1 than on Ir or Pt. Especially, $Pt_{0.2}Ir_{0.8}$ shows the highest activity for ammonia oxidation. These results may suggest that there exists a kind of interaction between Pt and Ir for the electrocatalysis.

REFERENCES

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2. Y. Takasu, T. Fujiwara, Y. Murakami, K. Sasaki, M. Oguri, T. Asaki and W. Sugimoto, *J. Electrochem. Soc.*, **147**, 4421 (2000).
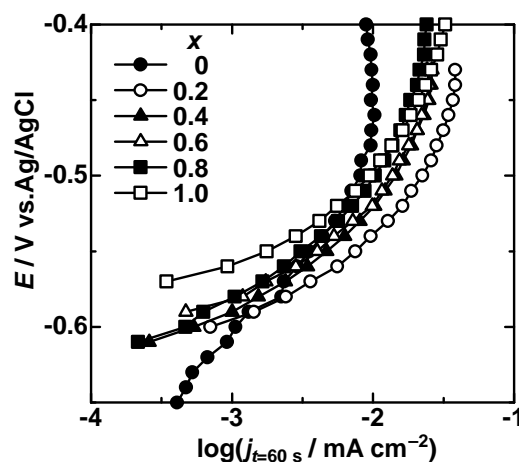
Fig. 1 Potentiostatic polarization curves for NH_3-oxidation on Pt_xIr_{1-x} in 0.1 M NH_3 + 1 M KOH at 25℃.
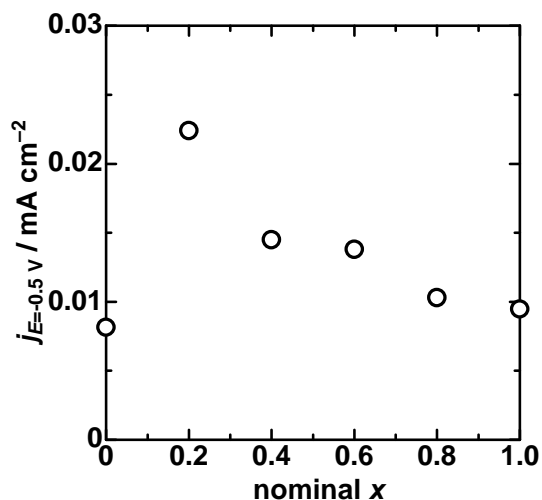

Fig. 2 Dependence of $j_{E=-0.5\,V}$ on nominal x in Pt_xIr_{1-x}.